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METHOD AND APPARATUS FOR PROVIDING HAPTIC FEEDBACK UTILIZING MULTI-ACTUATED WAVEFORM PHASING

RELATED APPLICATIONS

This application is related to the following co-pending applications, each assigned to the Assignee of the present invention.

a. application Ser. No. 11/823,192, filed Jun. 26, 2007, entitled "Method and Apparatus for Multi-touch Tactile Touch Panel Actuator Mechanisms";

b. application Ser. No. 11/823,258, filed Jun. 26, 2007, entitled "Method and Apparatus for Multi-touch Haptic Touch Panel Actuator Mechanisms"; and

c. application Ser. No. 11/943,862, filed Nov. 21, 2007, entitled "Method and Apparatus for Providing a Fixed Relief Touch Screen with Locating Features Using Deformable Haptic Surfaces."

d. application Ser. No. 12/061,463, filed Apr. 2, 2008, entitled "Method and Apparatus for Providing Multi-Point Feedback Texture Systems."

FIELD

The exemplary embodiment(s) of the present invention relates to a field of electronic interface devices. More specifically, the exemplary embodiment(s) of the present invention relates to generation of haptic feedback.

BACKGROUND

As computer-based systems, appliances, automated teller machines (ATM), point of sale terminals and the like have become more prevalent in recent years, the ease of use of the human-machine interface is becoming more important. Such interfaces should operate intuitively and require little or no user training whereby they may be employed by virtually anyone. Many conventional user interface devices are available on the market, such as key boards, mouse, joysticks, and touch screens. One of the most intuitive and interactive interface devices known is the touch panel, which can be a touch screen or a touch pad. A touch screen includes a touch sensitive input panel and a display device, and provides a user with a machine interface through a panel sensitive to the user's touch and displaying content that the user "touches." A conventional touch pad is a small planar rectangular pad, which can be installed near a display, on a computer, an automobile, ATM machines, and the like.

A conventional touch sensitive panel, for instance, usually has a smooth flat surface and uses sensors such as capacitive sensors and/or pressure sensors to sense locations being touched by a finger(s) and/or an object(s). A user, for example, presses a region or a point on a typical touch screen with a fingertip to emulate a button press and/or moves his or her finger on the panel according to the graphics displayed behind the panel on a display device.

A problem associated with a smooth flat surface touch screen is that it feels flat and smooth when a user touches the screen even though the image behind the surface shows an object such as a button. A conventional approach to compensate for flat and smooth touch feeling is to use haptic responses. To generate haptic responses that emulate an object such as a button, typical mechanical actuators or carriers, for instance, can be used to provide a virtual object or a barrier sensation.

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A drawback associated with the conventional approach for generating haptic response is that it relies on global motion of a mechanical carrier attached to the touch screen. Another drawback associated is that it is often difficult to generate clear or crisp haptic responses.

SUMMARY

A haptic mechanism capable of generating haptic feedback over a touch surface using multi-actuated waveform phasing is described. The haptic device, in one embodiment, includes a touch surface and a group of haptic actuators. The touch surface is capable of sensing an event, wherein the event can be a contact on the touch surface or a movement nearby the touch surface. A portion of the haptic actuators, which are coupled to the touch surface, is configured to provide haptic feedback on the touch surface in response to the event. Another portion of the haptic actuators is used to minimize unwanted haptic responses on the touch surface.

Additional features and benefits of the exemplary embodiment(s) of the present invention will become apparent from the detailed description, figures and claims set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

The exemplary embodiment(s) of the present invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

FIGS. 1(a-b) illustrate haptic devices capable of generating haptic feedback using multi-actuated waveform phasing in accordance with one embodiment of the present invention;

FIGS. 2(a-b) illustrate haptic devices capable of generating haptic feedback using multi-actuated waveform phasing across a touch surface in accordance with one embodiment of the present invention;

FIG. 3 illustrates an actuator capable of generating crisp haptic effects using multi-actuated waveform phasing in accordance with exemplary embodiment(s) of the present invention;

FIGS. 4(a-d) illustrate examples of haptic cells in a haptic device employing piezoelectric materials and Micro-Electro-Mechanical Systems ("MEMS") elements in accordance with one embodiment of the present invention;

FIG. 5(a-b) illustrates a side view of a haptic device having an array of haptic cells with thermal fluid pockets in accordance with one embodiment of the present invention;

FIG. 6(a-b) illustrates a haptic cell employing Micro-Electro-Mechanical Systems pumps to generate haptic effects in accordance with one embodiment of the present invention;

FIG. 7 illustrates a side view diagram for a haptic device having an array of haptic cells using variable porosity membrane in accordance with one embodiment of the present invention;

FIG. 8 is a side view of a haptic device having an array of haptic cells using various resonant devices in accordance with one embodiment of the present invention; and

FIG. 9 is a flowchart illustrating a process of generating haptic feedback using multi-actuated waveform phasing in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

Exemplary embodiments of the present invention are described herein in the context of a method, system and